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Health Consultation

EPA Region 5 Records Ctr.



222391

Review of Residential Well Water Sampling Data

HIMCO DUMP

ELKHART, ELKHART COUNTY, INDIANA

EPA FACILITY ID: IND980500292

MAY 14, 2001

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
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Health Consultation: A Note of Explanation

An ATSDR health consultation is a verbal or written response from ATSDR to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material. In order to prevent or mitigate exposures, a consultation may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material.

In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation process for this site, unless additional information is obtained by ATSDR which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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HEALTH CONSULTATION

Review of Residential Well Water Sampling Data

HIMCO DUMP

ELKHART, ELKHART COUNTY, INDIANA

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Prepared by:

Exposure Investigations and Consultations Branch
Division of Health Assessments and Consultations
Agency for Toxic Substances and Disease Registry

Background and Statement of Issue

Region 5 of the U.S. Environmental Protection Agency (EPA) asked the Agency for Toxic Substances and Disease Registry (ATSDR) to review and comment on the results of water samples collected in March and April 2000, from 12 residential wells at the secondary residential area southeast of the Himco Dump site (the site) (1).

The 40- 60-acre site is located at the intersection of County Road 10 and the Nappanee Extension, and has been used for open dumping of general refuse, industrial, medical, and pharmaceutical waste from 1960 to 1976. Agricultural and commercial properties are to the north and northeast, and residential areas are to the south, southeast, and east of the site.

Several federal and state government agencies, including EPA, U.S. Geological Survey (USGS), ATSDR, and the Indiana State Department of Health (ISDH) have conducted investigation, remediation, and assessment activities at this site since 1971. Between 1989 and 2000, ATSDR and EPA completed a public health assessment, a public health consultation, a remedial investigation and feasibility study (RI/FS), and a record of decision (ROD) (2).

Groundwater is the primary environmental medium of concern for this site. In 1990, ATSDR evaluated samples taken from residential wells at the first residential area south of the site and concluded that concentrations of sodium and other contaminants represent a chronic health threat to the affected residents. EPA requested the potentially responsible parties (PRPs) to finance the cost of connecting the affected residences to the municipal water supply (3). In 1993, the EPA ROD stated that some specific groundwater characteristics (low horizontal gradient, low upward vertical gradients, and fluctuations in water table levels) may affect the speed and mechanism of the contaminants' migration from the landfill waste mass to the groundwater system. The general groundwater flow direction is to the south, and southeast of the site (18). Recently, there was a concern that the groundwater contamination plume is moving from its natural course towards the east (1).

This health consultation evaluates analytical data on the well water samples collected by EPA, Region 5, and addresses the short- and long-term health effects of ingesting contaminated well water for the residents and community located east of the site.

Discussion

The potential health effects from ingesting contaminated well water depends on several factors, such as (1) the type and amount of contaminants, (2) the amount of water ingested, (3) the duration of ingestion, and (4) individual susceptibilities. ATSDR uses *different comparison values* (CVs) (i.e., all of the chemical-specific, health-based standards and guidelines) derived by various government agencies to identify contaminants that require further evaluation for possible health effects. ATSDR uses the following standard assumptions for calculating CVs: 2 liters of water (0.5 gallon) consumption per day for adults weighing 70 kilograms (154 pounds) and 1 liter of

water consumption per day for children weighing 10 kilograms (22 pounds). ATSDR has established the following CVs for evaluating contaminants in the environment: minimal risk levels (MRLs), environmental media evaluation guidelines (EMEGs), reference dose media evaluation guides (RMEGs), and cancer risk evaluation guides (CREGs). In this health consultation, the following CVs are used: the ATSDR CVs (MRLs, EMEGs, RMEGs, CREGs), the EPA drinking water maximum contaminant levels (MCLs), the EPA secondary drinking water guidelines (SDWG), the EPA drinking water equivalent level (DWEL) and the American Heart Association's recommendation for daily sodium intake. *Conservative assumptions used in setting those CVs do not imply that a level greater than the screening value will necessarily lead to harmful health effects.* Appendix A summarizes ATSDR CVs and provides definitions.

The primary contaminants of concern in the residential well water are arsenic, 1,2-dichloropropane, sodium, and vinyl chloride. These chemicals were found in some samples at levels above their respective CVs. In addition, levels of manganese and iron found in some samples exceeded the EPA SDWG.

The primary route of human exposure is ingestion of the contaminated water at this site. Inhalation exposure was not given further consideration because of (1) very low levels of volatile organic chemicals (i.e., 0.016 parts per million for 1,2-dichloropropane, and 0.0026 parts per million for vinyl chloride) were estimated to release into air during showering and other uses, and (2) exposures to these levels are expected to be for short duration. Because of the lipid barrier of the skin, the absorption of contaminants through dermal exposure is considered to be minimal. Contaminants that exceeded their respective CVs are discussed below.

Arsenic

Arsenic is a naturally occurring element, present at low levels in soil, water, food, and air. The average level of arsenic found in drinking water supplies in the United States is 2 micrograms per liter ($\mu\text{g/L}$). Drinking water from ground water sources tend to have higher levels of arsenic than surface water sources (i.e., lakes and rivers). Some areas of the country contain high natural levels of arsenic in drinking water. For example, parts of the Midwest (including Indiana) have some water systems whose current arsenic levels are greater than 10 $\mu\text{g/L}$ (4, 17).

The potential health effects from ingesting water containing arsenic depends on the (1) concentration of arsenic, (2) amount of water ingested, and (3) duration of ingestion. At low levels of exposure, the body is able to effectively eliminate arsenic without suffering toxic effects. However, when the body's capacity to detoxify low levels of arsenic is exceeded, blood arsenic levels increase and adverse health effects occur (4). The long-term, chronic effects of exposure to low concentrations (at least several hundred $\mu\text{g/L}$) of inorganic arsenic in drinking water include increased risk of developing cancer of the bladder, lung, skin, kidney, nasal passages, liver, and prostate. The National Toxicity Program (NTP) classifies inorganic arsenic compounds as known human carcinogens based on evidence in humans. Non-cancer effects of chronically ingesting arsenic-contaminated water include skin changes (e.g., skin pigmentation and keratosis),

cardiovascular, pulmonary, immunological, neurological, and endocrine (e.g., diabetes) effects. Those effects have been detected at concentrations of 350 $\mu\text{g/L}$ or above. Short-term exposure to high levels (300–30,000 $\mu\text{g/L}$) of arsenic can cause other adverse health effects, but such effects are unlikely to occur from water supplies containing arsenic at levels below 50 $\mu\text{g/L}$. EPA is helping to establish a new arsenic standard to reduce the arsenic concentration from the current MCL of 50 $\mu\text{g/L}$ to a lower level (17). (See Table 1 for a summary of health effects at different levels of exposure to inorganic arsenic through oral ingestion from human studies.)

The concentration of arsenic in the samples collected ranged from “not detected” to 8 $\mu\text{g/L}$, below the EPA current MCL for arsenic of 50 $\mu\text{g/L}$. The ATSDR’s MRL for arsenic is 0.3 micrograms per kilogram per day ($\mu\text{g/kg/day}$) for chronic oral exposure to arsenic. The MRL is an estimate of daily human exposure to arsenic that is likely to be without an appreciable risk of adverse health effects (noncarcinogenic) over a 1-year period. It is based on a no-observed-adverse-effect level (NOAEL) for skin lesions in humans, with an uncertainty (safety) factor of three for human variability(5). Consuming this water is unlikely to exceed the MRL and cause adverse health effects. In terms of cancer risk, persons with a long-term exposure (continuously over a lifetime) to an arsenic level of 8 $\mu\text{g/L}$ may face a low, theoretical increased risk of developing cancer (i.e., no more than one excess cancer in every 10,000 persons exposed over a lifetime). (The dose calculations are described in Appendix B). However, no study has reported any actual increase in cancer rates at doses below 1 $\mu\text{g/kg/day}$ via drinking water.

1,2-dichloropropane

1,2-dichloropropane is a man-made chemical used in cleaning solutions, paint strippers, varnishes, and soil fumigants. It is a VOC which can evaporate quickly at room temperature and is mostly found in the air and in groundwater. High levels of acute oral exposure to this chemical (i.e., drinking cleaning solutions) produce such health effects as dizziness, headache, nausea, and injure the liver and kidney. No reports have been made of any health effects in humans following chronic low-level oral exposure to this chemical. Animal studies at very high doses (above 125,000 $\mu\text{g/kg/day}$ for mice) have showed marginal, but statistically significant, increased incidence of certain cancers (liver and breast). No study was located in the scientific literature regarding carcinogenic effects in humans following oral exposure to this chemical (6). EPA classified 1,2-dichloropropane as a probable human carcinogen with sufficient evidence in animals and no evidence in humans. Therefore, EPA established an MCL of 5 $\mu\text{g/L}$ for the chemical, based on cancer and non-cancer effects, as well as cost and feasibility for cleanup in public water sources (7). (Table 2 summarizes health effects at different levels of exposure to 1,2-dichloropropane through oral ingestion from animal studies.)

1,2-dichloropropane was not detected in most of the water samples, with the exception of one well (# 54305W), which contained levels of 10 $\mu\text{g/L}$ and 8 $\mu\text{g/L}$, respectively, for the samples taken in March and April 2000. Consumption of the well water containing a maximum 10 $\mu\text{g/L}$ of 1,2-dichloropropane is unlikely to cause adverse health effects. In terms of cancer risk, persons who have a long-term exposure (continuous lifetime exposure) to the chemical at levels of 10 $\mu\text{g/L}$ face no apparent increased risk of developing cancer. (See Appendix B for dose calculations.)

Vinyl Chloride

Vinyl chloride is a colorless gas, which is manufactured, or results from the breakdown of other manufactured substances. It enters the environment at hazardous waste sites through improper disposal, leakage, spills, and the breakdown of other chemicals. Only a limited amount of vinyl chloride can dissolve in water, and it evaporates rapidly when near the surface. Most human studies on the health effects of vinyl chloride were for inhalation exposures in industrial settings at high levels. No reports have been made of any health effects in humans following oral exposure to vinyl chloride. Animal studies have suggested that ingestion of drinking water containing low levels (above 300 $\mu\text{g}/\text{kg}/\text{day}$ for rats) of vinyl chloride may increase the risk of getting liver cancers (8). (Table 3 summarizes health effects at different levels of exposure to vinyl chloride through oral ingestion from animal studies.)

Vinyl chloride is not detected in most of water samples collected, with the exception of two samples (# EDCK8 and EDCK2) which contain estimated levels of 0.9 $\mu\text{g}/\text{L}$ and 0.7 $\mu\text{g}/\text{L}$, respectively. (These values are estimated to be above the method detection limit and below the reporting limit.) These values are below the EPA vinyl chloride MCL of 2 $\mu\text{g}/\text{L}$. The MRL for chronic oral exposure to vinyl chloride is 0.02 $\mu\text{g}/\text{kg}/\text{day}$. This MRL is based on a lowest-observed-adverse-effect level (LOAEL) for liver effects in rats, with a safety factor of 1,000. Consumption of the well water containing a maximum of 0.9 $\mu\text{g}/\text{L}$ vinyl chloride are unlikely to cause any adverse health effects. In terms of cancer risk, persons who have a long-term exposure (continuous lifetime exposure) to a vinyl chloride level of 0.9 $\mu\text{g}/\text{L}$ face no apparent increased risk of developing cancer. (The dose calculations are described in Appendix B)

Contaminants with Secondary MCLs (Manganese and Iron)

EPA established non-enforceable SDWGs to maintain the aesthetic quality of water, including its taste and odor. The concentrations of manganese and iron in some residential well water samples were above their respective non-health-based standards.

Both manganese and iron are essential elements required for normal human growth and maintenance of health. The Food and Nutrition Board of the Institute of Medicine recommends that a tolerable upper intake level (UL) for adults is 11 mg/day of manganese and 45 mg/day of iron. UL is the highest level of daily nutrient intake that is likely to pose no risk of adverse health effects for almost all individuals (9). The EPA SDWGs for manganese and iron are 0.05 and 0.3 mg/L, respectively. At concentration above the SDWGs, manganese and iron may cause undesirable tastes, deposit on foods during cooking, and leave brownish-black (manganese) or reddish-brown (iron) stains on plumbing fixtures and laundry. Manganese and iron are also essential elements for certain nonpathogenic bacteria which form red-brown or black-brown slime on plumbing fixtures (7).

Reports of adverse effects in humans resulting from manganese exposure are associated primarily with inhalation exposure in occupational settings. Ingested manganese has rarely been associated with toxicity. Although there are no conclusive data, epidemiological studies suggested an association between ingesting water containing elevated manganese (about 2 mg/L) and development of mild neurological symptoms. The LOAEL was observed at 0.059 mg/kg/day over a 50-year exposure period (10).

ATSDR's RMEG for manganese in drinking water is 2 mg/L (5). The highest concentration of manganese found in the well water samples is 1.88 mg/L, below the RMEG and levels that have been shown to cause adverse effects in animals and humans. Infants and children may be more susceptible to increased manganese exposure. (The dose calculations and UL for manganese at different age are described in Appendix B).

Infants and young children may take up more manganese than adults because animal studies indicated that infant rats take in and retain more manganese than adult rats. Neurotoxic effects have been observed in infants with liver disease who were exposed to elevated levels of manganese through their diet. Some studies indicated that learning or behavioral impairment may be a concern for children exposed to elevated levels of manganese through their diet (11, 19). (Table 4 summarizes the health effects at different levels of exposure to manganese through oral ingestion from animal studies.)

Iron toxicity depends upon the amount of iron ingested and absorbed by the human body. Iron in water is poorly absorbed by the human body. Adverse effects in humans resulting from dietary sources are rare, however, iron toxicity can occur from ingesting iron supplements. Iron poisoning has occurred in young children who have ingested 3 grams (3,000 mg) of iron. Many diseases can influence iron absorption and in turn iron toxicity. Persons who are diagnosed with hemochromatosis, a genetically based iron accumulation disease, may be sensitive to iron exposure and should consult their physicians regarding the need to limit iron ingestion from food and water sources (9). The water samples contained from 0.019 to 6.12 mg/L of iron. These levels are below levels that have been shown to cause adverse effects in the general population. High dietary intake of iron and other metals may lead to decreased oral absorption of manganese (11).

Sodium

Sodium is an essential mineral for maintaining proper cell function and cell fluid balance (9). EPA has not established a MCL for sodium. However, EPA's DWEL for sodium in drinking water is 20 mg/L, on the basis of its association with hypertension (12). EPA is currently reviewing its guidance value for sodium and may revise its guidance value upward (12). Most Americans ingest several thousand milligrams of sodium per day in food. Processed foods are high in sodium. The American Heart Association recommends that healthy adults limit their sodium intake to 2,400 mg of sodium per day (13). An adult, consuming 2 liters of water per day containing 200 mg/L of sodium, would ingest 400 mg of sodium, or 17% of their recommended daily sodium intake from

water. Adults who should restrict their sodium intake to 1,000 mg of sodium per day, would consume 40% of the recommended daily sodium intake from water. The levels of sodium found in the well water (highest concentration was 126 mg/L in sample # S05) would not represent a health concern to residents if the well water was the primary source of sodium for them. However, residents who should limit their sodium intake may not achieve the prescribed limit if well water represents a substantial proportion of their daily sodium intake (because of the high sodium content of the food supply). Therefore, the incremental increase of sodium from ingesting sodium-containing water over years may be of health concern to sensitive and hypertensive persons.

Health Effects of Mixtures

ATSDR's CVs (MRLs, EMEGs, RMEGs, CREGs) are typically 10–1,000 times lower than the corresponding NOAELs. Studies conducted by the National Toxicology Program (NTP) and the Netherlands Organization for Applied Scientific Research (TNO) Nutrition and Food Research Institute generally support the conclusion that exposure to a mixture of chemicals is unlikely to produce any adverse health effects if the components of that mixture are present at levels well below their respective NOAELs. Even chemicals with the same or similar modes of action apparently exhibit neither synergism nor additivity if the levels of exposure are well below the respective NOAELs of the component chemicals (14-16).

Virtually all of the individual contaminants detected in the water samples are present at levels that are far below levels known to produce adverse health effects (noncarcinogenic). Furthermore, some contaminants (i.e., manganese, iron and other metals) may interact with each other and lead to decreased oral absorption. For the above reasons, the combined effects of all the contaminants are unlikely to be of public health concern.

Limitations

The following issues should be noted about the contamination of the well water:

- *Unknown and complicated aquifer conditions* – There is not enough information to identify the site groundwater flow direction, groundwater level fluctuations and groundwater seasonal variations. Groundwater upward fluctuation was a concern because such flow may result in direct contact between groundwater and the waste mass thereby effecting the speed and mechanism of the contaminants migration.
- *Degradation of landfill confining layer integrity* – EPA has not yet identified any existing landfill cap in this landfill. The PRPs used large amounts of calcium sulfate at the site. The concentrations of calcium in some monitoring well water samples increased recently.
- *Limited sample number and unknown sampling depth* – There are approximately 200 residential homes in the community. Water samples have been taken from 12 residential wells. The depths of ground water recharge for those wells were unknown.

- *Unknown residential well construction quality* – Most of the residential wells were constructed before 1976. The construction details were not available and the well's integrity could not be verified
- *Other concerns* – Unpleasant taste, odor, and color of residential well water is a concern for the community. Drinking water quality can be affected not only by contamination of chemicals, but also the presence of microbial contaminants. Unpleasant taste, odor, and color of water can be caused by elevated levels of iron, manganese, and sodium, as well as some types of bacteria. Contaminants of all kinds may enter poorly constructed wells easier than wells of good quality. Another community concern is the diminished quality of life associated with the site. Some residences experienced gastrointestinal irritation symptoms such as chronic abdominal pains, vomiting and diarrhea. There are many causes for the above symptoms (e.g., ingestion of food and/or water contaminated with certain chemical and microbial agents, medication and herb remedies, mental and physical stress, etc.). However, it is beyond the scope of this health consultation to investigate the causes of the symptoms.

Although the most recent residential well water sampling and literature review results indicated that the levels of chemicals in residential well water are unlikely to cause any adverse health effects, the impact of long term exposure to the residential well water is uncertain because of the above-mentioned considerations.

ATSDR's Child Health Initiative

ATSDR considers children in the evaluation of all exposures, and the agency uses health guidelines that are protective for children. In evaluating any potential health effects from ingestion, children were considered as a special population because of their body weight, and unique susceptibility to chemicals. In formulating conclusions for this health consultation, ATSDR considered children to be more sensitive than adults to excessive intake of arsenic, vinyl chloride, and manganese. No exposures were identified that expected to cause adverse health effects in the general population of children. However, for children who should limit their sodium intake may not achieve their prescribed limit if well water ingestion represents a substantial proportion of their daily sodium intake.

Conclusions

On the basis of a review of the toxicological literature, a comparison of levels in residential wells to published standards and guidance values, and an evaluation of the exposure duration and the population exposed, ATSDR concludes that

1. Under current conditions, ingestion of residential well water from the secondary residential area east of the site is unlikely to cause adverse health effects in the general population. However, sensitive populations, including those persons with hypertension, diabetes, and heart disease who should limit their sodium intake may not achieve their

prescribed limit if well water ingestion represents a substantial proportion of their daily sodium intake. Therefore, the incremental increase of sodium through ingesting sodium-containing well water over long periods may be of health concern to sensitive persons and those who are hypertensive.

2. Long-term (continuous lifetime exposure) ingestion of the water from the secondary residential area to an arsenic level of $8 \mu\text{g/L}$ may have a low, theoretical increased risk of developing cancer for exposed populations (i.e., no more than one excess cancer in every 10,000 persons exposed over a lifetime). However, no measureable increase in cancer rates is expected at the above level of exposure.
3. All of the individual contaminants detected are present at levels that are far below levels known to produce adverse health effects. For this reason, the combined effects of all contaminants present at the site are unlikely to be of public health concern.
4. Because exposure level variation is still possible due to seasonal changes, uncontrolled contamination sources, and limitations of the environmental data, ATSDR will reevaluate the site if critical, new information or data becomes available.

Recommendations

ATSDR recommends the following:

1. Consider use of an alternate source of drinking water (e.g., municipal water supply) for the following community residents:
 - Sensitive populations (including persons under medical advisement to limit sodium intake) whose residential wells contain sodium levels above 50 mg/L. This recommendation is made to limit the proportion of daily sodium intake from ingestion of private well water for those persons who have been advised to restrict their sodium intake. (Consuming 2 liters of water per day with 50 mg/L of salt results in 10% of the daily sodium intake for those persons who have been advised to restrict their sodium intake to 1,000 mg per day.)
 - Those whose well water contains levels of 1,2-dichloropropane above the EPA MCL of $5 \mu\text{g/L}$.
 - Those whose overall quality of life is impacted by the unpleasant taste, odor, and color of their well water.
2. Conduct periodic monitoring of the well water to ensure that contaminant levels remain below the ATSDR and EPA safe values.

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Appendix A

ATSDR Comparison Values and Definitions

ATSDR's Comparison Values

ATSDR comparison values (CVs) are media-specific concentrations considered "safe" under default exposure scenario. They are used as screening values to identify contaminants (site-specific substances) that require further evaluation to determine the potential for adverse health effects.

Generally, a chemical is selected for further evaluation because its maximum concentration in air, water, or soil at the site exceeds one of ATSDR's CVs. However, CVs are *not* thresholds of toxicity. While concentrations at or below the relevant CV may reasonably be considered safe, it does not automatically follow that any environmental concentration that exceeds a CV would be expected to produce adverse health effects. The purpose of highly conservative, health-based standards and guidelines is to help health professionals recognize and resolve potential public health problems *before* they become actual health hazards. The probability that adverse health outcomes will actually occur as a result of exposure to environmental contaminants depends on several factors, including site specific conditions, individual lifestyle, genetic factors that affect the route, magnitude, and duration of actual exposure, and *not* on environmental concentrations alone.

Screening values based on non-cancer effects are obtained by dividing NOAELs or LOAELs determined in animal or (less often) human studies by cumulative safety margins (variously called safety factors, uncertainty factors, and modifying factors) that typically range from 10 to 1,000 or more. By contrast, cancer-based screening values are usually derived by linear extrapolation from animal data obtained at high doses, because human cancer incidence data for very low levels of exposure simply are nonexistent.

Listed and described below are the various CVs that ATSDR uses to select chemicals for further evaluation, along with the abbreviations for the most common units of measure.

aEMEG	Environmental Media Evaluation Guide based on acute Minimal Risk Level
CLHA	Child Longer-Term Health Advisory
CMRL	Chronic Risk Level
CREG	Cancer Risk Evaluation Guides
DWEL	Drinking Water Equivalent Level
EMEG	Environmental Media Evaluation Guides
IMRL	Intermediate Risk Level
kg	Kilogram (1,000 grams)
L	Liter

LOAEL	Lowest-observed-adverse-effect Level
LTHA	Drinking Water Lifetime Health Advisory
mg	Milligram (0.001 gram)
m ³	Cubic Meter (used in reference to a volume of air equal to 1,000 liters)
MCL	Maximum Contaminant Level
MCLA	Maximum Contaminant Level Action
MCLG	Maximum Contaminant Level Goal ($\mu\text{g/L}$)
MRL	Minimal Risk Level
NOAEL	No-observed-adverse-effect Level
NPDWR	National Primary Drinking Water Regulation
NSDWR	National Secondary Drinking Water Regulation
ppm	Parts Per Million, e.g., mg/L or mg/kg
ppb	Parts Per Billion, e.g., $\mu\text{g/L}$ or $\mu\text{g/kg}$
RBCs	Risk-Based Concentrations
RfC	Reference Dose Concentration
RfD	Reference Dose
RMEG	Reference Dose Media Evaluation Guide
TT	Treatment Technique
μg	Microgram (0.000001 gram)

Cancer Risk Evaluation Guides (CREGs) are estimated contaminant concentrations in water, soil, or air that would be expected to cause no more than one excess cancer in 1,000,000 persons exposed over a lifetime. CREGs are calculated from EPA's cancer slope factors.

Child Longer-Term Health Advisories (CLHAs) are contaminant concentrations in water that EPA deems protective of public health (taking into consideration the availability and economics of water treatment technology) over a period of about 7 years, using a child's weight (10 Kg) and ingestion rate (1 L/day).

Drinking Water Equivalent Levels (DWEL) are based on EPA's oral RfD and represent corresponding concentrations of a substance in drinking water that are estimated to have negligible adverse health effects in humans over a lifetime of exposure, at an intake rate of 2

L/day, and assuming that drinking water is the sole source of exposure to the contaminant DWELs are similar to ATSDR's RMEG for drinking water

Environmental Media Evaluation Guides (EMEGs) are concentrations of a contaminant in water, soil, or air that are unlikely to be associated with any appreciable risk of adverse non-cancer effects over a specified duration of exposure. EMEGs are derived from ATSDR minimal risk levels using default body weights and ingestion rates. Separate EMEGs are computed for acute (≤ 14 days), intermediate (15–364 days), and chronic (≥ 365 days) exposures.

EPA's Reference Dose (RfD) is an estimate of the daily exposure to a contaminant unlikely to cause non-carcinogenic adverse health effects over a lifetime of exposure. EPA's RfD is a dose expressed in mg/kg/day.

Intermediate Environmental Media Evaluation Guides (IEMEG) are media-specific concentrations that correspond to a minimal risk level, factoring in body weight and ingestion rates for intermediate exposures (i.e., >14 days and <1 year).

Lowest-observed-adverse-effect levels are the lowest exposure level of chemical in a study, or group of studies, that produces statistically or biologically significant increase in frequency or severity of adverse health effects between the exposed population and its appropriate control.

Maximum Contaminant Levels (MCLs) represent contaminant concentrations in drinking water that EPA deems protective of public health (considering the availability and economics of water treatment technology) over a lifetime at an exposure rate of 2 L/day.

Maximum Contaminant Level Action (MCLA) are levels set by EPA that trigger a regulatory response when the contaminant concentration exceeds this value.

Maximum Contaminant Level Goals (MCLGs) are drinking water health goals set at levels at which no known or anticipated adverse health effects occur, allowing for an adequate margin of safety. Such levels consider the possible impact of synergistic effects, long-term and multi-stage exposures, and the existence of more susceptible groups in the population. When there is no safe threshold for a contaminant, the MCL should be set at zero.

Minimal Risk Levels (MRL) are estimates of daily human exposure to a chemical (i.e., doses expressed in mg/kg/day) that are unlikely to be associated with any appreciable risk of adverse non-cancer effects over a specified duration of exposure. MRLs are derived for acute (≤ 14 days), intermediate (15–364 days), and chronic (≥ 365 days) exposures, and are published in ATSDR's Toxicological Profiles for specific chemicals.

National Primary Drinking Water Regulation (NPDWR or primary standard) is a legally enforceable standard that applies to public water systems. Primary standards protect drinking water quality by limiting the levels of specific contaminants that can adversely affect public health and are known or anticipated to occur in water. They take the form of MCLs or Treatment Techniques.

National Secondary Drinking Water Regulation (NSDWR or secondary standard) is a non-enforceable guideline regarding contaminants that may cause cosmetic effects (such as skin or tooth discoloration) or aesthetic effects (such as taste, odor, or color) in drinking water.

No-observed-adverse-effect level is the dose of a chemical at which there were no statistically or biologically significant increase in frequency or severity of adverse health effects seen between the exposed population and its appropriate control. Effects may be produced at this dose, but they are not considered to be adverse.

Reference Dose Media Evaluation Guide (RMEG) is the concentration of a contaminant in air, water or soil that corresponds to EPA's RfD or RfC for that contaminant when default values for body weight and intake rates are taken into account.

Risk-Based Concentrations (RBCs) are media-specific concentrations derived by the EPA region 3, for carcinogens and non-carcinogens from RfDs and Cancer Slope Factors, respectively, assuming default values for body weight, exposure duration and frequency, etc. They represent concentrations of a contaminant in tap water, ambient air, fish, or soil (industrial or residential) that are considered unlikely to cause adverse health effects over a lifetime of exposure.

Treatment Technique (TT) is a legally enforceable procedure or level of technological performance which public water systems must follow. When there is no reliable method that is economically and technically feasible to measure a contaminant at particularly low concentration, A TT is set rather than an MCL.

Appendix B

Dose Calculations